ผลของการฝึกความเร็วอดทนโดยใช้แรงต้านแบบยางยืดเปรียบเทียบกับการฝึกแบบการวิ่งต่อสมรรถภาพแอโรบิกและแอนแอโรบิกในนักกีฬาฟุตซอลเยาวชน

The Effects of Elastic Resistance–Based Versus Running-Based Speed Endurance Training on Aerobic and Anaerobic Performance in Youth Futsal Players

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาและเปรียบเทียบผลของการฝึกความเร็วอดทนโดยใช้แรงต้านจากยางยืดและการฝึกความเร็วอดทนด้วยการวิ่งที่มีต่อสมรรถภาพด้านแอโรบิกและแอนแอโรบิกในนักกีฬาฟุตซอลเยาวชน กลุ่มตัวอย่างเป็นนักกีฬาฟุตซอลเยาวชน อายุ 16–18 ปี จำนวน 32 คน แบ่งเป็น 2 กลุ่ม กลุ่มละ 16 คน ด้วยวิธีการสุ่มแบบจับคู่ กลุ่มที่ 1 ฝึกความเร็วอดทนโดยใช้แรงต้านจากยางยืด และกลุ่มที่ 2 ฝึกความเร็วอดทนด้วยการวิ่ง ทั้งสองกลุ่มฝึกเป็นเวลา 4 สัปดาห์ สัปดาห์ละ 3 ครั้ง ที่ความเข้มข้นประมาณ 85% ของความเร็วสูงสุดในการวิ่งสปรินต์ การทดสอบสมรรถภาพแอโรบิกใช้แบบทดสอบ Multistage Fitness Test (Beep Test) และสมรรถภาพแอนแอโรบิกใช้แบบทดสอบ Running-Based Anaerobic Sprint Test (RAST) ประกอบด้วยตัวแปรความสามารถแอนแอโรบิก กำลังสูงสุด และดัชนีความล้า วิเคราะห์ข้อมูลด้วยสถิติ Paired t-test และ Independent t-test กำหนดระดับนัยสำคัญทางสถิติที่ 0.05 ผลการวิจัยพบว่า กลุ่มที่ฝึกความเร็วอดทนโดยใช้แรงต้านจากยางยืดมีการพัฒนาความสามารถแอนแอโรบิก (p = 0.005) และดัชนีความล้า (p = 0.021) อย่างมีนัยสำคัญทางสถิติ ขณะที่กลุ่มฝึกความเร็วอดทนด้วยการวิ่งไม่พบการเปลี่ยนแปลงอย่างมีนัยสำคัญในตัวแปรดังกล่าว เมื่อเปรียบเทียบระหว่างกลุ่มหลังการฝึก ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติในทุกตัวแปร ($p > 0.05$) สรุปได้ว่าการฝึกความเร็วอดทนโดยใช้แรงต้านจากยางยืดสามารถพัฒนาความสามารถแอนแอโรบิกและลดดัชนีความล้าได้ภายในกลุ่ม อย่างไรก็ตาม ยังไม่สามารถยืนยันได้ว่ามีประสิทธิผลเหนือกว่าการฝึกความเร็วอดทนด้วยการวิ่ง เนื่องจากไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติระหว่างกลุ่ม จึงควรมีการศึกษาเพิ่มเติมโดยใช้ระยะเวลาการฝึกที่ยาวขึ้นและกลุ่มตัวอย่างที่มากขึ้น

คำสำคัญ: ความเร็วอดทน, การฝึกด้วยยางยืด, ความสามารถแอโรบิก, ความสามารถแอนแอโรบิก, ฟุตซอล

Abstract

This study aimed to compare the effects of elastic resistance–based speed-endurance training and running-based speed-endurance training on aerobic and anaerobic performance in youth futsal players. Methods: Thirty-two youth futsal players aged 16–18 years were assigned to two groups (n = 16 per group) using matched-pair randomization. The Elastic Resistance Group (ERG) performed speed-endurance training with elastic resistance, whereas the Running-Based Group (RBG) performed running-based speed-endurance training. Both groups trained for 4 weeks, 3 sessions per week, at approximately 85% of maximal sprint velocity. Aerobic performance was assessed using the Multistage Fitness Test (Beep Test), while anaerobic performance was evaluated using the Running-Based Anaerobic Sprint Test (RAST), including anaerobic capacity, peak anaerobic power, and fatigue index. Data were analyzed using paired and independent t-tests with statistical significance set at $p < 0.05$. Results: The ERG demonstrated significant improvements

in anaerobic capacity (p = 0.005) and fatigue index (p = 0.021). No significant changes were observed in the RBG for these variables. However, no statistically significant differences were found between groups in any outcome measure following the intervention (p > 0.05). Conclusion: Elastic resistance–based speed-endurance training produced significant within-group improvements in anaerobic capacity and fatigue resistance. However, superiority over running-based speed-endurance training was not statistically confirmed because no significant between-group differences were observed. These findings suggest that elastic resistance training may be a promising conditioning strategy for youth futsal players, although further research is required.

Keywords: Speed-endurance, Elastic resistance training, Aerobic capacity, Anaerobic capacity, Youth futsal players

1. Introduction

Futsal is a high-intensity intermittent team sport characterized by frequent transitions between offensive and defensive phases, repeated accelerations and decelerations, changes of direction, and explosive actions performed under considerable time pressure. These match demands require players to repeatedly execute high-intensity movements while maintaining technical and tactical performance throughout the competition. Recent evidence indicates that elite futsal players are exposed to substantial physiological, neuromuscular, and metabolic stress during both training and match play, highlighting the importance of well-developed physical fitness capacities (Spyrou et al., 2022).

Due to the intermittent nature of futsal, both aerobic and anaerobic energy systems contribute significantly to performance. Players must possess adequate aerobic fitness to facilitate recovery between high-intensity efforts, while anaerobic capacity is essential for repeated sprinting, rapid accelerations, and explosive movements. Furthermore, physical qualities such as muscular strength, power, speed, agility, and neuromuscular coordination have been identified as key determinants of successful futsal performance (Albalad-Aiguabella et al., 2025; González-Fernández et al., 2024).

Among these physical qualities, speed endurance is particularly important because it enables athletes to sustain repeated high-intensity efforts while delaying the onset of fatigue. Enhanced speed endurance contributes to improved sprint performance, repeated acceleration ability, and movement efficiency during the later stages of competition, where fatigue often impairs performance. Consequently, training methods that simultaneously develop strength and speed-related capacities have become increasingly relevant in modern futsal conditioning programs (Albalad-Aiguabella et al., 2025).

One practical training approach is elastic resistance training (ERT), which provides variable resistance throughout the range of motion and allows athletes to perform sport-specific movements under externally imposed loading conditions. Unlike traditional resistance methods, elastic bands progressively increase resistance as they elongate, creating a unique loading profile that may better accommodate natural strength curves during movement. Recent evidence suggests that elastic band training can effectively improve sprint performance, change-of-direction ability, explosive power, and sport-specific physical performance in team-sport athletes (Stanković et al., 2025).

From a physiological perspective, elastic resistance training may induce favorable neuromuscular adaptations, including enhanced motor-unit recruitment, increased neural drive, improved intermuscular coordination, and greater force production capacity. These adaptations are considered fundamental mechanisms underlying improvements in athletic performance, particularly during explosive and repeated

high-intensity activities. Recent reviews have highlighted the importance of resistance training-induced neuromuscular adaptations for enhancing strength, power, and movement efficiency in athletic populations (Aslam et al., 2025; Rong et al., 2025).

Furthermore, resistance-based training interventions have been shown to improve movement economy and physical performance by increasing the neuromuscular demands imposed during exercise. Variable and elastic resistance methods may also enhance sprint performance and repeated high-intensity exercise capacity through improvements in force production and neuromuscular efficiency (Shi et al., 2022; Van Hooren et al., 2024). Given the high-intensity and repeated-sprint nature of futsal, elastic resistance training may represent an effective strategy for enhancing speed endurance and related performance capacities.

Despite the growing popularity of elastic resistance training, evidence regarding its effectiveness for improving speed endurance in youth futsal players remains limited. Most previous studies have focused on football players or have investigated resistance training and running-based conditioning separately. Moreover, few studies have directly compared elastic-resistance-based speed-endurance training with conventional running-based speed-endurance training in futsal-specific populations. This gap in the literature is important because the physiological and movement demands of futsal differ from those of other team sports and may require sport-specific conditioning strategies to maximize performance outcomes (Ribeiro et al., 2025).

Therefore, the purpose of this study was to compare the effects of elastic-resistance-based speed-endurance training and running-based speed-endurance training on aerobic capacity and anaerobic performance in youth futsal players. The findings may provide practical evidence for coaches, strength and conditioning specialists, and sport scientists seeking effective and sport-specific conditioning methods for improving futsal performance.

2. Materials and methods

The study protocol was approved by the Human Research Ethics Committee of Udon Thani Rajabhat University (Approval No. 132/2024). Written informed consent was obtained from all participants and their parents or legal guardians before participation because all participants were minors. The following sections describe the study participants, training program, outcome assessments, and statistical procedures.

2.1 Subjects

This study employed a matched-pairs randomized experimental design with two parallel groups. The participants were 32 youth futsal players (aged 16–18 years) from Phibunrak Pittaya School, Udon Thani, Thailand. Sample size was determined using GPower version 3.1 (Faul et al., 2009) with an effect size of 0.50, statistical power of 0.80, and alpha level of 0.05, resulting in a minimum required sample of 32 participants.

Aerobic capacity was assessed using the Multistage Fitness Test, and participants were ranked according to their estimated VO_2max values. Participants were then matched in pairs according to VO_2max and randomly allocated by lottery into either the elastic-resistance group or the running-based group (16 participants per group). This procedure ensured baseline equivalence between groups. Each group consisted of 16 participants, resulting in a total sample of 16 males and 16 females.

2.2 Training Program

The speed-endurance training program (Tables 1 and 2) was conducted for 4 weeks, 3 sessions per week. Training intensity was prescribed at approximately 85% of maximal sprinting effort, determined from the participants' individual maximal sprint performance during familiarization testing.

Training intensity was monitored throughout the intervention using sprint completion time and Rating of Perceived Exertion (RPE; Borg CR-10 scale). Participants were required to maintain sprint times within ±5% of their baseline maximal sprint performance. If performance dropped below the target range, additional recovery was provided.

The duration of each session was standardized to 60 minutes and consisted of 10 minutes of warm-up, 40 minutes of speed-endurance training, and 10 minutes of cool-down.

Before each training session, participants completed a standardized warm-up consisting of 5 minutes of light jogging followed by dynamic stretching exercises involving the lower extremities and trunk musculature.

Table 1. Training Program for the Elastic Resistance Speed Endurance Group

Day	Type of Activities	Type of Movement	Duration
Monday	Warm Up	Static or Dynamic Stretching in Major Muscle Groups	10 minutes
Wednesday Friday	Work Out	For the elastic resistance training, the program was structured into three progressive rounds: • **Round 1:** Two elastic bands on each side • **Round 2:** One elastic band on each side • **Round 3:** No elastic resistance Each round was performed for 10 seconds. **Weeks 1–2**, participants performed 3 rounds per set, for a total of 4 sets, with a rest interval of 3 minutes between sets. **Weeks 3–4**, participants performed 3 rounds per set, for a total of 5 sets, with a rest interval of 2.5 minutes between sets.	40 minutes
	Cool Down	Static Stretching in Major Muscle Groups	10 minutes

Table 2. Training Program for the Running-Based Speed Endurance Group

Day	Type of Activities	Type of Movement	Duration
Monday Wednesday Friday	Warm Up	Static or Dynamic Stretching in Major Muscle Groups	10 minutes
	Work Out	The running program consisted of 20-meter shuttle runs. **Weeks 1–2**, Continuous running for 30 seconds per set, completing 4 sets with 3 minutes of rest between sets. **Weeks 3–4**, Continuous running for 30 seconds per set, completing 5 sets with 2.5 minutes of rest between sets.	40 minutes
	Cool Down	Static Stretching in Major Muscle Groups	10 minutes

2.3 Procedures

2.3.1 Body composition: subjects' mass (weight) and height were used to calculate Body Mass Index (BMI). The BMI was expressed in kilograms per square meter ($kg \cdot m^{-2}$) with mass in kilograms and height in meters. It was calculated by dividing body mass by the square of the body height.

2.3.2 Multistage Fitness Test (Beep Test): Aerobic fitness was assessed using the 20-m Multistage Fitness Test, commonly known as the Beep Test. This test is widely used to estimate maximal oxygen uptake (VO_{2max}) in athletes and youth populations (Léger et al., 1988). Participants ran back and forth between two lines set 20 meters apart, following audio signals from the standardized Beep Test recording. The initial running speed was 8.5 km/h and increased by 0.5 km/h at each stage. Participants were required to reach the 20-m line before or at the sound signal. The test was terminated when a participant failed to reach the line on two consecutive signals or voluntarily stopped due to fatigue. The final stage and shuttle completed were recorded. The maximal running speed corresponding to the final attained stage was subsequently used to estimate VO_2max. The test was conducted on a flat indoor futsal court under similar environmental conditions for all participants. Estimated VO_{2max} was calculated using the equation proposed by Léger et al. (1988):

$$VO_{2max} = 31.025 + 3.238V - 3.248A + 0.1536\,(V \times A) \quad (1)$$

where

VO_2max = estimated maximal oxygen uptake ($mL \cdot kg^{-1} \cdot min^{-1}$)

V = maximal running speed ($km \cdot h^{-1}$)

A = age (years)

2.3.3 Running-Based Anaerobic Sprint Test (RAST): Anaerobic performance was assessed using the Running-Based Anaerobic Sprint Test (RAST), which is a valid and practical field test for evaluating anaerobic power and fatigue in running-based sports (Zagatto et al., 2009). Before the test, participants performed a standardized warm-up consisting of light jogging, dynamic stretching, and short acceleration runs. The RAST consisted of six maximal 35-m sprints, with 10 seconds of passive recovery between each

sprint. Sprint time for each repetition was recorded using a stopwatch or timing gates. Participants were instructed to perform each sprint with maximal effort. Power output for each sprint was calculated using the following equation: Power (W) = Body mass × Distance² ÷ Time³. where body mass is expressed in kilograms, distance is 35 meters, and time is recorded in seconds. The following variables were calculated: Peak power: the highest power value across the six sprints, Minimum power: the lowest power value across the six sprints, Mean power: the average power value across all six sprints, Fatigue index: the decline in power across repeated sprints.

2.3.4 The fatigue index**:** was calculated as: Fatigue index = (Peak power – Minimum power) ÷ Total sprint time. A lower fatigue index indicates a better ability to maintain anaerobic performance during repeated high-intensity efforts.

2.4 Statistical Analyses

Data normality was assessed using the Shapiro–Wilk test. Baseline characteristics between groups were compared using independent-samples t-tests. Intervention effects were analyzed using a two-way repeated-measures ANOVA (Group × Time). Significant interactions were followed by Bonferroni-adjusted post hoc comparisons. Effect sizes were calculated using partial eta squared (η^2p) and Cohen's d. Ninety-five percent confidence intervals (95% CI) were reported for all primary outcome variables. Statistical significance was set at $p < 0.05$.

3. Results

Table 3 presents the baseline characteristics of the participants in the Elastic Resistance Group (ERG) and the Running-Based Group (RBG). No significant differences were observed between groups for body weight, height, body fat percentage, body mass index (BMI), or aerobic capacity (VO_2max) ($p > 0.05$). These findings indicate that both groups were comparable at baseline.

Table 3. The Characteristics of the Participants

Variables	ERG	RBG	*p*-value
Body weight (kg)	64.18 ± 15.40	62.51 ± 13.46	0.162
Height (cm)	171.18 ± 5.13	172.63 ± 6.39	0.252
Body fat (kg)	11.82 ± 9.28	10.40 ± 9.57	0.391
BMI (kg/m²)	21.88 ± 5.00	21.10 ± 5.07	0.445
VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$)	33.54 ± 7.23	33.60 ± 7.80	0.268

Note: Values are presented as Mean ± SD.ERG = Elastic Resistance Group.RBG = Running-Based Group

Table 4 presents within-group changes following the four-week intervention. Significant improvements were observed in anaerobic capacity ($p = 0.005$) and fatigue index ($p = 0.021$) in the ERG. No significant changes were observed in VO_2max or peak anaerobic power. In contrast, the RBG did not demonstrate significant improvements in any of the measured variables.

The improvement in anaerobic capacity observed in the ERG may enhance repeated sprint performance, acceleration, and high-intensity actions during the futsal competition. Likewise, the reduction in fatigue index indicates an improved ability to maintain performance during repeated maximal efforts, which may be beneficial during the latter stages of match play.

Table 5. presents the between-group comparisons at pre-test and post-test. No significant differences were observed between groups at either assessment point ($p > 0.05$).

Table 4. Aerobic and Anaerobic Performance Within Groups

Variables	Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t	*p*–value
VO_2max (ml·kg^{-1}·min^{-1})	ERG	33.54 ± 7.23	34.89 ± 9.30	-1.705	0.119
	RBG	33.60 ± 7.80	34.26 ± 9.66	-.472	0.647
Anaerobic capacity (W/kg)	ERG	7.03 ± 0.72	7.82 ± 1.20	-3.624	0.005*
	RBG	7.19 ± 1.13	7.86 ± 0.95	-2.139	0.058
Peak anaerobic power (W/kg)	ERG	9.52 ± 2.55	11.00 ± 2.19	-2.134	0.059
	RBG	10.23 ± 1.42	10.83 ± 1.46	-1.098	0.298
Fatigue index (%)	ERG	70.74 ± 12.20	59.23 ± 11.04	2.745	0.021*
	RBG	65.42 ± 14.54	62.46 ± 17.67	0.352	0.732

Note: Significantly different from pre-test to post-test within the same group ($p < .05$). ERG = Elastic Resistance Group.RBG = Running-Based Group.

Table 5. Comparison of Aerobic and Anaerobic Performance Between Groups

Variables	Time	ERG Mean ± SD	RBG Mean ± SD	t	*p*–value
VO_2max (ml·kg^{-1}·min^{-1})	Pre	33.54 ± 7.23	33.60 ± 7.80	-.017	0.987
	Post	34.89 ± 9.30	34.26 ± 9.66	.155	0.878
Anaerobic capacity (W/kg)	Pre	7.03 ± 0.72	7.19 ± 1.13	-.408	0.688
	Post	7.82 ± 1.20	7.86 ± 0.95	-.092	0.928
Peak anaerobic power (W/kg)	Pre	10.05 ± 1.37	10.23 ± 1.42	-.303	0.765
	Post	11.00 ± 2.19	10.83 ± 1.46	.213	0.843
Fatigue index (%)	Pre	70.74 ± 12.20	65.42 ± 14.54	.928	0.365
	Post	59.23 ± 11.04	62.46 ± 17.67	-.514	0.614

Note: ERG = Elastic Resistance Group.RBG = Running-Based Group.

Table 6 To provide a more comprehensive evaluation of training effects, mean changes (**Δ**), effect sizes (Cohen's d), and 95% confidence intervals were calculated.

The ERG demonstrated a large improvement in anaerobic capacity (d = 1.80) and a moderate reduction in fatigue index (d = -0.72), whereas the RBG demonstrated only small-to-moderate changes. Although the ERG generally showed larger improvements across several performance variables, differences in change scores did not reach statistical significance ($p > 0.05$).

Therefore, both training methods may be considered effective for improving selected aspects of performance; however, elastic-resistance speed-endurance training tended to produce greater practical improvements in anaerobic performance and fatigue resistance in youth futsal players.

Table 6. Mean Change (Δ), Effect Size, and Confidence Interval

Variable	ERG Δ Mean ± SD	Cohen's d	95% CI	RBG Δ Mean ± SD	Cohen's d	95% CI	*p*-value
VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	+1.78 ± 2.85	0.62	-0.61 to 4.16	+1.01 ± 5.48	0.18	-3.57 to 5.59	0.732
Anaerobic Capacity	+1.06 ± 0.59	1.80	0.57 to 1.55	+0.58 ± 1.19	0.49	-0.41 to 1.57	0.323
Anaerobic capacity (W/kg)	+0.81 ± 2.04	0.40	-0.89 to 2.51	+0.87 ± 2.32	0.37	-1.07 to 2.81	0.959
Fatigue Index	-9.76 ± 13.59	-0.72	-21.12 to 1.60	-0.14 ± 27.60	-0.01	-23.22 to 22.93	0.391

4. Discussion

The present study investigated the effects of elastic resistance–based speed-endurance training and running-based speed-endurance training on aerobic and anaerobic performance in youth futsal players. The main findings indicated that the Elastic Resistance Group (ERG) demonstrated significant improvements in anaerobic capacity and fatigue index following the intervention, whereas the Running-Based Group (RBG) did not show significant changes in these variables. However, no statistically significant differences were observed between groups at post-test.

The improvement in anaerobic capacity observed in the ERG may be practically relevant for futsal performance because anaerobic fitness is closely associated with repeated sprint ability, acceleration, rapid changes of direction, and the ability to perform high-intensity actions throughout a match. Likewise, the reduction in fatigue index may indicate an enhanced capacity to sustain performance during repeated maximal efforts, which is particularly important during the latter stages of competitions when fatigue accumulates.

These findings are generally consistent with previous studies reporting positive effects of elastic resistance training on sprint performance, muscular power, and repeated high-intensity exercise capacity (Loturco et al., 2016; Lopes et al., 2019). Elastic resistance provides variable external loading throughout movement, which may increase neuromuscular demands while preserving sport-specific movement patterns. Nevertheless, some previous studies have reported larger improvements in sprint-related performance than those observed in the present study. Such differences may be attributed to variations in training duration, resistance magnitude, participant characteristics, and sport-specific training demands.

Importantly, the present findings do not support the conclusion that elastic resistance–based speed-endurance training is superior to running-based speed-endurance training. Although the ERG demonstrated significant within-group improvements and generally larger effect sizes, the absence of statistically significant between-group differences indicates that both training approaches may provide comparable benefits for youth futsal players.

Several physiological mechanisms may help explain the observed adaptations. Recent evidence suggests that resistance training can enhance motor-unit recruitment, increase neural drive, improve intermuscular coordination, and optimize neuromuscular efficiency, thereby contributing to improvements in force production and athletic performance (Škarabot et al., 2021; Aslam et al., 2025; Rong et al., 2025). These neuromuscular adaptations may improve athletes' ability to perform repeated high-intensity efforts and delay fatigue during intermittent sports such as futsal match play. However, because physiological variables related to these mechanisms were not directly measured in the present study, such explanations

should be interpreted as potential mechanisms rather than confirmed adaptations resulting from the intervention.

The lack of statistically significant between-group differences may be explained by several factors. First, the intervention period was relatively short (4 weeks), which may not have been sufficient to induce substantial training adaptations that could distinguish one method from the other. Second, the relatively small sample size may have limited the statistical power to detect small-to-moderate between-group effects. Third, both groups performed active speed-endurance training protocols, which may have elicited similar physiological adaptations. Finally, individual differences in biological maturation and training responsiveness among adolescent athletes may have contributed to variability in the results.

Several limitations of the present study should be acknowledged. The intervention period was relatively short, the sample size was limited, and male and female athletes were analyzed together. In addition, biological maturation status was not controlled, training-load monitoring was limited, and the use of field-based performance tests may have introduced measurement error. Furthermore, the absence of a non-training control group restricts the ability to distinguish intervention effects from normal developmental changes. Future studies should include larger sample sizes, longer intervention periods, more comprehensive load-monitoring procedures, and direct physiological measurements to better understand the mechanisms underlying performance adaptations.

Practical Applications: For coaches and practitioners, elastic resistance–based speed-endurance training may be incorporated into futsal conditioning programs as an alternative training strategy to enhance anaerobic performance and fatigue resistance. This method is relatively inexpensive, portable, and easy to implement within sport-specific training environments. Coaches may also consider combining elastic resistance sprint drills with conventional running-based speed-endurance training to simultaneously develop neuromuscular, anaerobic, and aerobic fitness components required for futsal performance. Nevertheless, current evidence remains insufficient to conclude that elastic resistance–based training is more effective than traditional running-based speed-endurance training.

5. Conclusion

This study demonstrated that elastic resistance–based speed endurance training significantly improved anaerobic capacity and fatigue index in youth futsal players, whereas running-based speed endurance training did not produce significant changes in these variables. Although the Elastic Resistance Group generally demonstrated larger improvements in anaerobic performance variables, no statistically significant differences were observed between groups. Therefore, the findings do not support the conclusion that elastic resistance training is superior to running-based speed endurance training. Nevertheless, elastic resistance training appears to be a promising training modality for improving anaerobic performance and fatigue resistance in youth futsal players. Coaches may consider incorporating elastic resistance exercises into speed-endurance programs as part of a comprehensive conditioning strategy. Further research with larger sample sizes, longer intervention periods, and more rigorous physiological assessments is required before stronger conclusions regarding the comparative effectiveness of elastic resistance training can be made.

6. Reference

Albalad-Aiguabella, R., Navarrete-Villanueva, D., Mainer-Pardos, E., Villanueva-Guerrero, O., Muniz-Pardos, B., & Vicente-Rodríguez, G. (2025). Physical Training Considerations for Futsal Players According to Strength and Conditioning Coaches: A Qualitative Study. Sports, 13, 126. https://doi.org/10.3390/sports13040126

Aslam, S., Habyarimana, J. D. D., & Bin, S. Y. (2025). Neuromuscular adaptations to resistance training in elite versus recreational athletes. Frontiers in physiology, 16,1598149. https://doi.org/10.3389/fphys.2025.1598149

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. Behavior research methods, 41(4), 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

González-Fernández, F. T., Ceylan, H. I., Silva, R., Clemente, F. M., Bezerra, P., & Chen, Y. (2024). Relationships between physical fitness and match running demands during a futsal congested-weeks training camp. Biology of Sport, 41(4), 11-30. https://doi.org/10.5114/biolsport.2024.134760

Léger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (2007). The multistage 20 metre shuttle run test for aerobic fitness. Journal of sports sciences, 6(2), 93-101. https://doi.org/10.1080/02640418808729800

Lopes, J. S. S., Machado, A. F., Micheletti, J. K., de Almeida, A. C., Cavina, A. P., & Pastre, C. M. (2019). Effects of training with elastic resistance versus conventional resistance on muscular strength: A systematic review and meta-analysis. SAGE open medicine, 7, 1-7 https://doi.org/10.1177/2050312119831116

Loturco, I., Pereira, L. A., Kobal, R., Maldonado, T., Piazzi, A. F., Bottino, A., Kitamura, K., Abad, C. C. C., Arruda, M., & Nakamura, F. Y. (2016). Improving sprint performance in soccer: effectiveness of jump squat and Olympic push press exercises. PloS one, 11(4), e0153958. https://doi.org/10.1371/journal.pone.0153958

Ribeiro, J. N., Ferraz, A., Gonçalves, B., Serrano, C., Coutinho, D., Ballester, R., & Travassos, B. (2025). Training exercises, match demands, and variability in elite futsal. Frontiers in Sports and Active Living, 7, 1553046. https://doi.org/10.3389/fspor.2025.1553046

Rong, W., Geok, S. K., Samsudin, S., Zhao, Y., Ma, H., & Zhang, X. (2025). Effects of strength training on neuromuscular adaptations in the development of maximal strength: a systematic review and meta-analysis. Scientific reports, 15(1), 19315. https://doi.org/10.1038/s41598-025-03070-z

Shi, L., Cai, Z., Chen, S., & Han, D. (2022). Acute effects of variable resistance training on force, velocity, and power measures: a systematic review and meta-analysis. PeerJ, 10, e13870. https://doi.org/10.7717/peerj.13870

Škarabot, J., Brownstein, C. G., Casolo, A., Del Vecchio, A., & Ansdell, P. (2020). The knowns and unknowns of neural adaptations to resistance training. European journal of applied physiology, 121(3), 675-685. https://doi.org/10.1007/s00421-020-04567-3

Spyrou K, Freitas TT, Marín-Cascales E, Herrero-Carrasco R, Alcaraz PE. (2022). External match load and the influence of contextual factors in elite futsal. Biology of Sport, 39(2), 349-354. https://doi.org/10.5114/biolsport.2022.105332

Stanković, D., Lazić, A., Trajković, N., Okičić, M., Bubanj, A., Vencúrik, T., Gašić, T., & Bubanj, S. (2025). Effects of Elastic Band Training on Physical Performance in Team Sports: A Systematic Review and Meta-Analysis. Journal of Functional Morphology and Kinesiology, 10(4), 402. https://doi.org/ 10.3390/jfmk10040402

Van Hooren, B., Aagaard, P., & Blazevich, A. J. (2024). Optimizing resistance training for sprint and endurance athletes: balancing positive and negative adaptations. Sports Medicine, 54(12), 3019-3050. https://doi.org/10.1007/s40279-024-02110-4

Zagatto, A. M., Beck, W. R., & Gobatto, C. A. (2009). Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short-distance performances. Journal of Strength and Conditioning Research, 23(6), 1820-1827. https://doi.org/10.1519/JSC.0b013e3181b3df32